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METHOD FOR REDUCING DEFORMATIONS OF FERROCONCRETE BEARING CONSTRUCTIONS

Filed Jan. 30, 1939

Serial No. 253,479½

2 Sheets-Sheet 1

FIG. 1.

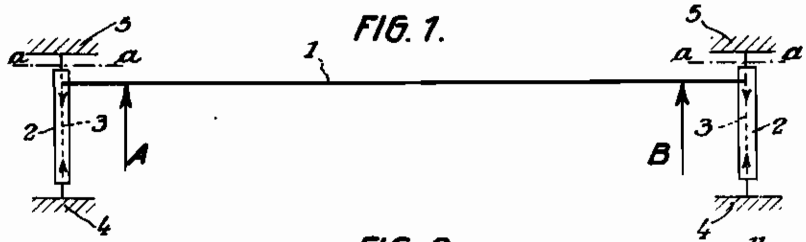


FIG. 2.

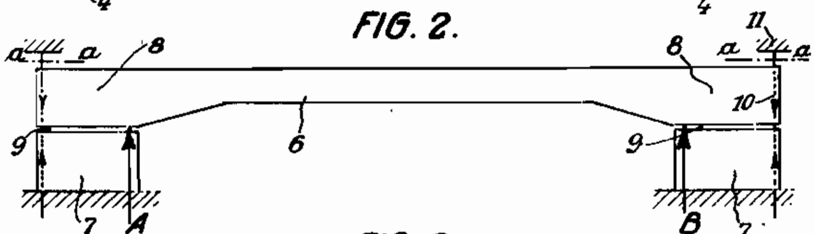


FIG. 3.

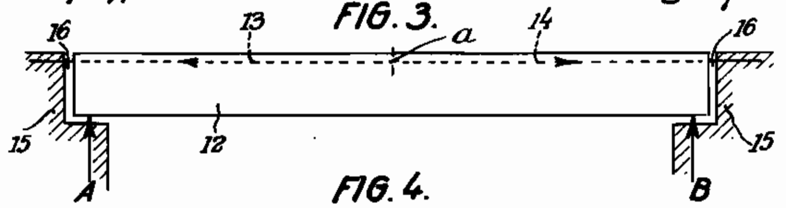


FIG. 4.

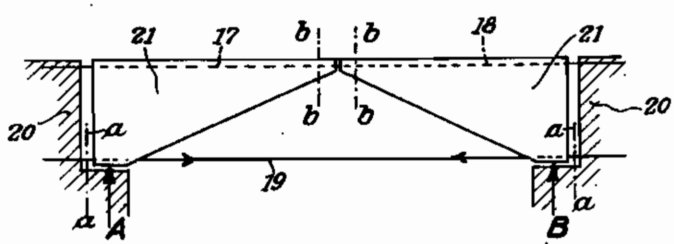
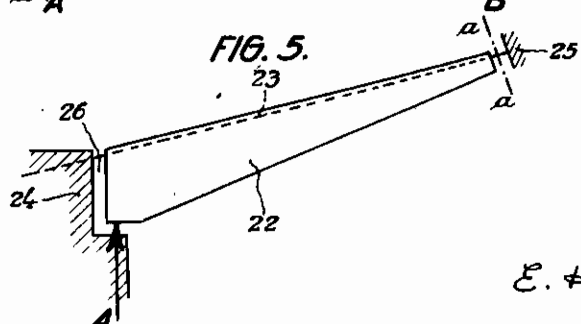


FIG. 5.



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2 Sheets-Sheet 2

FIG. 6.

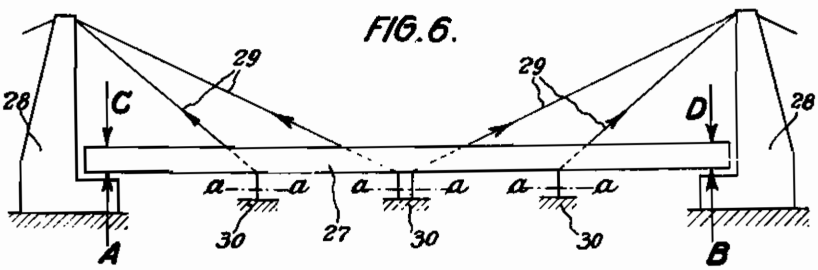


FIG. 7.

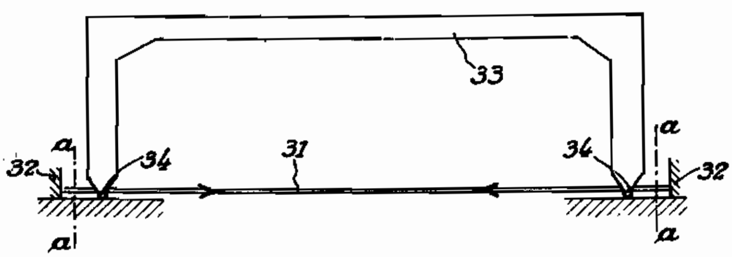
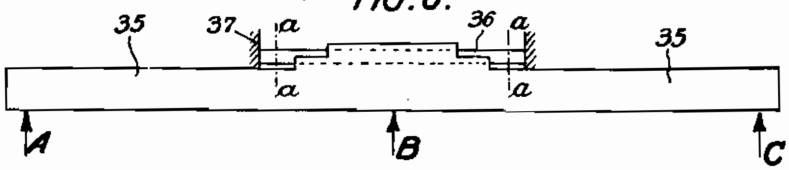


FIG. 8.



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ALIEN PROPERTY CUSTODIAN

METHOD FOR REDUCING DEFORMATIONS OF FERROCONCRETE BEARING CONSTRUCTIONS

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Application filed January 30, 1939

The invention relates to the production of ferroconcrete bearing constructions of larger dimensions, such as halls and bridges etc. with wide spans. In constructions with wide spans considerable deformations, especially deflections, are caused by external loads (dead weight, useful load, etc.). These deformations of ferroconcrete constructions may be counteracted by tensioned reinforcements. However, in the case of large ferroconcrete constructions with wide spans, such reinforcements, setting up internal forces, are not sufficient to prevent detrimental deformations.

It is known, especially in the case of certain ferroconcrete constructions, such as arched bridges with suspended road-ways, to use tensioned straps in order to counteract deformation or deflection. However, the use of such straps tensioned within the arched bridge is limited to this type of bridge or to similar constructions. In addition, special care has to be taken in transmitting the tension of the straps to the ferroconcrete construction, these straps being tensioned gradually while incorporating the reinforcements.

In contrast with this procedure, the method according to the invention consists in using tensioned straps acting as external forces upon the ferroconcrete bearing construction. In accordance with the invention, the straps are, for this purpose, anchored with one end in fixed supports and are then tensioned independently of the bearing construction, and while or after the latter is completed, the tension is removed from the other ends of the straps. In this way external forces are introduced into the bearing construction by the straps anchored at one end, initially counteracting deformations caused by external loads. In applying this new method, the straps are made of tensioned concrete, i. e. the highly tensioned reinforcing members, for example highly tensioned steel wires, are incorporated in the concrete in this tensioned state, and not until the concrete has hardened, the tension is removed from the one end of the straps. Suitably constructed straps may at the same time serve to reinforce the bearing construction, the deformation of which is thus reduced by both external and internal forces transmitted by these straps. All deformations of the bearing construction, including those of the traps, are thus reduced to a minimum. The new method permits not only of improving and strengthening the known types of statically determinable and undeterminable ferroconcrete constructions, but also of developing entirely new types of constructions.

The accompanying drawing illustrates, by way of examples, ferroconcrete bearing constructions produced according to the new method.

Fig. 1 is a diagrammatic illustration of a cantilever girder.

Fig. 2 is a different type of cantilever girder.

Fig. 3 is a tensioned ferroconcrete girder with two supports.

Fig. 4 is a three hinged arch.

Fig. 5 is a socle-girder.

Fig. 6 is a bridge construction.

Fig. 7 is a two hinged frame.

Fig. 8 is a continuous girder.

The cantilever girder 1 made of ferroconcrete, as illustrated in Fig. 1, rests on the two supports A and B, the ends of the girder being attached to the straps 2 of tensioned concrete, acting as external forces. The reinforcing members 3 of these straps are highly tensioned between the two points 4 and 5 and are then covered with concrete. Not until the girder 1 is completed, the tension is removed at point 5 of the strap, for example by cutting the reinforcing member along the line *a—a*. The straps 2 then act as external forces on the girder 1 by causing a bending moment opposite to the load of the girder, thus preventing the latter from deflecting.

In fixing the girder, it is also possible to reduce the tension at point 5 before covering the straps 3 with concrete, thus transmitting a certain amount of initial tension to the girder 1 by the straps 3. Then, the straps 3 are covered with concrete, and after the latter has hardened, the tension at point 5 is removed entirely.

An advantageous practical construction of a girder according to Fig. 1 is illustrated in Fig. 2. The ferroconcerete girder 6 rests on the supports 7 at A and B in such a way that a space 9 remains between the ends 8 of the girder and the supports 7. The straps 10 consisting of steel wires or the like are anchored in the supports 7 and, being temporarily fixed to point 11, are subjected to a high tension. After completion of the girder 6, the tension at point 11 is removed by cutting the straps along the line *a—a*, whereby the tension of the straps 10 is automatically transmitted to the ends 8 of the girder 6. Naturally, the straps 10 must be rigidly connected to the ends 8 of the girder before removing the tension, for example by letting the straps 10 act on the girder by means of anchor plates. This special anchoring is, however, not necessary if very thin steel wires are used, the friction of such thin wires in the concrete and the face pressure being sufficient to transmit the tension.

The space 9 between the ends 8 of the girder and the supports 7 is advantageously filled with concrete. By filling concrete into the space 9 before removing the tension at point 11, the concrete between the ends 8 of the girder and the supports is subjected to a compressive stress. In this manner, a ferroconcrete girder fixed at both ends is obtained.

Fig. 3 illustrates a ferroconcrete girder 12 resting on two supports A and B with the straps 13 and 14 acting as adidtional external forces and advantageously consisting of continuous reinforcing members, highly tensioned and anchored in the supports 15. After completion of the girder 12, the tension of the straps is removed in the middle of the girder by cutting the continuous reinforcing members at the points *a*. Thus, individual straps 13, 14 are formed, causing a pressure or a bending moment in the girder 12, counteracting the opposite bending moment caused by the load. The spaces 16 between the girder 12 and the supports 15 are advantageously filled with concrete so that the girder illustrated in Fig. 3 acts like a fixed girder.

Fig. 4 shows a three hinged arch with straps 17 and 18 and a lower tension member 19. The production of this three hinged arch is similar to that shown in Fig. 3 and consists in first anchoring the continuous straps 17, 18, advantageously made of one piece, in the supports 20 and then subjecting them to a high tension. In the same way, the lower tension member 19 is tensioned between the supports 20. After completion of the pieces 21 of the arch, this tension member is, for example, released by cutting along the lines *a*—*a*, thus transmitting the entire initial tension of this tension member to the hinged arch. Then the straps 17, 16 are cut at the points *b*—*b*, thereby transmitting the initial tension of these straps to the two pieces 21 of the arch. Thus, two external tensile forces are set up in the direction towards the supports 20, acting upon the arches 21 at the top and causing a bending moment which counteracts the load.

Fig. 5 shows a socle-girder 22 with straps 23 anchored in the support 24 and temporarily fixed to a point 25 outside the construction and highly tensioned. After completion of the socle-girder 22 the tension at point 25 is removed by cutting the straps, whereby the tension of the straps 23 is transmitted to the girder 22. These straps 23 are advantageously arranged inside the girder 22 so as to serve at the same time as reinforcement members of this girder and to cause a compressive stress. The space 26, provided between the socle-girder 22 and the support 24, may be filled with concrete, which should be done before removing the tension from point 25, thus producing a kind of tensioned girder at this place too.

Fig. 6 shows a new ferroconcrete bridge construction, being a combination of a suspension-bridge and a fixed girder. The fixed ferroconcrete girder 27 rests on supports A and B of the two pillars 28 and is also held by supports from the top. The straps 29 connected to this girder are anchored with one of their ends in supports not shown in the drawing and are conducted over the pillars 28. The other ends of the straps are fixed below the girder at points 30 and are highly tensioned. This tension in the straps may also be produced by attaching loads to the ends of the straps or at the points 30.

These straps may be arranged so as to carry all scaffoldings and other articles required for building the bridge. In this case, the initial tension of the straps should be higher than the load for which the girder 27 is intended. These highly tensioned straps are covered with concrete, and after completion of the girder 27 the tension of the straps 20 is removed at the points *a*. The extended straps have the tendency to return to their former unloaded position. Being rigidly connected to the girder 27, they release the latter by producing moments in the girder in a direction opposite to the load. In this way it is possible to produce ferroconcrete bridge constructions with wide spans without causing fissures and subject to very slight deformations as compared with constructions of known type.

The straps consisting of tensioned concrete may also be used for other ferroconcrete constructions, for example for a two hinged frame as illustrated in Fig. 7. This is provided with straps 31 tensioned between two supports 32 and passing through concrete within the frame 33 to which they are fixed at the points 34. After completion of the frame, the tension is removed from the supports 32 by cutting the straps at the points *a*—*a*, so as to transmit the tension of the straps 31 to the frame 33, producing a horizontal force which counteracts the horizontal movement caused by loading the frame.

The method described with the aid of Fig. 7 may also be applied to arched bridges. The horizontal movement at the ends of the arches caused while incorporating the reinforcing members is counteracted by the highly tensioned straps, reducing the tension at the ends of the straps, i. e. between supports 32 and fixing points 34 in Fig. 7. By applying this method, the tension of the straps is automatically transmitted to the construction.

Fig. 8 shows a continuous ferroconcrete girder 35 resting on supports A, B, C. The bending moments at the supporting points of the continuous girder are balanced by straps 36 which are first highly tensioned between the points 37. After the straps have been covered with concrete, for example as shown in Fig. 8, the tension is removed from the points 37 by cutting the straps at the places *a*—*a*.

The reinforcing members of the straps may consist, for example, of steel rods or steel wires. As stated above, the use of thin steel wires of, for example, 0.5 to 4 mm diameter and having a strength of approximately 12000 to 30000 kgs. per sq. cm., has the advantage that no special anchoring is required. Moreover, the use of such strong wires permits the application of a very high initial tension. Even in the case of comparatively short straps made of such steel wires, the extension caused by the initial tension is comparatively great, so that it is also possible to transmit the calculated tensile forces of short strips with certainty.

EWALD HOYER.